Signalling transmission using phase rotation techinques in digital communications system

Patent number:	CN1354945
Publication date:	2002-06-19
Inventor:	HEK M (SE); JAVERBRING S (SE)
Applicant:	ERICSSON TELEFON AB L M (SE)
Classification:	
- international:	H04L27/18; H04L5/12
- european:	H04L5/12; H04L27/00M; H04L27/18
Application number:	CN19990801815 19990811
Priority number(s):	US19980170127 19981013

Also published as:

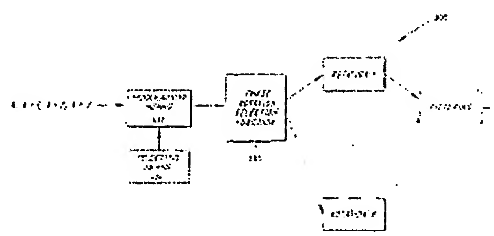
- WO0010301 (A3
- WO0010301 (A2
- EP1021898 (A3)
- EP1021898 (A2)
- US6473506 (B1)

more >>

Report a data error he

Abstract not available for CN1354945
Abstract of corresponding document: **US6473506**

In a telecommunications system, such as a cellular radio telecommunications system, transmission information, such as modulation scheme selection information, coding information or power level control commands, is efficiently conveyed from the transmitter to the receiver without increasing the bandwidth requirements and without introducing additional transmission delays. This can be accomplished by employing a data symbol phase rotation technique, wherein a sequence of data symbols, for example, a sequence of training symbols used for estimating the propagation characteristics of a given channel, are phase-rotated in accordance with a phase rotation factor that uniquely corresponds to the information being conveyed to the receiver. At the receiver, the symbols are de-rotated until the receiver recovers the training sequence. This allows the receiver to determine the phase rotation factor used to rotate the symbols at the transmitter. This, in turn, identifies the corresponding transmission information.



Signalling transmission using phase rotation techinques in digital communications system

Description of corresponding document: US6473506

FIELD OF INVENTION

[0002] The present invention generally relates to digital telecommunications systems. More particularly, the present invention relates to the transmission of information from a transmitter to a receiver without increasing the bandwidth requirement and without introducing transmission delays.

BACKGROUND

[0003] Digital telecommunications systems typically employ one or more modulation schemes to communicate information such as voice, data and/or control information. These modulation schemes may include, GMSK (Gaussian Minimum Shift Keying), M-ary QAM (Quadrature Amplitude Modulation), or M-ary PSK (Phase Shift Keying), where M denotes the number of modulation symbols specified for the different modulation schemes. The different modulation symbols correspond to different information symbols to be transmitted. In M=2 modulation schemes, for example, there are only two different modulation symbols specified. Hence, an M=2 modulation scheme is referred to as a binary modulation scheme.

[0004] The different types of modulation may be affected differently by the quality of the communication channel, i.e., different schemes may be more or less susceptible to distortion, time dispersion C/I ratios and the like. Accordingly, it is said that different modulation schemes have different levels of robustness. Generally, as the number of modulation symbols increases, i.e., as the value of M increases, the modulation scheme tends to be less robust. There are, however, other factors that influence the robustness of a modulation scheme, for example, the symbol rate. The symbol rate may also be specified differently for a given modulation scheme as well as between different modulation schemes.

[0005] In order to assure adequate communication quality with respect to e.g., information bit rates and error rates, link adaptation may be utilized. Depending on the (time-varying) quality of the communication channel, which may be affected by, for example, noise level, interference, path loss and time dispersion, a link adaptation strategy assures that an appropriate modulation scheme, channel coding, source coding, bandwidth and signal power level are chosen to obtain a link quality that satisfies user demands in terms of error rates, throughput and the like. To be truly effective, the link adaptation technique must be capable of monitoring and/or measuring the channel conditions over relatively short periods of time. Then, based on the present channel conditions, the system selects the modulation scheme or schemes that optimize link quality.

[0006] Telecommunications systems that employ Time Division Multiple Access (TDMA) divide the available frequency band into several RF channels. Each of these RF channels are then further divided into several physical channels or time slots. Voice, data and/or control information is then transmitted in bursts, wherein a burst corresponds to a physical channel or time slot. In a TDMA based system, link adaptation and modulation selection is typically accomplished on a burst-by-burst basis. It will be understood, however, that link adaptation is not limited to TDMA systems. Rather, link adaptation may also be performed in systems based on other access principles. For example, in CDMA (Code Division Multiple Access) Systems, one may vary, e.g., coding, modulation and spreading factors to achieve a desired link quality.

[0007] An important aspect of any link adaptation and modulation selection technique is the way in which the transmitter informs the receiver of the modulation scheme selected for a particular burst of information. Probably, the most straight-forward technique for informing the receiver as to the modulation scheme associated with a particular burst of information involves signaling the receiver in advance. However, this technique is highly undesirable as it results in additional overhead (i.e., an increase in the bandwidth requirement) which, in turn, results in transmission delays.

[0008] Another technique for conveying modulation selection information to the receiver involves the use of training sequences. As one skilled in the art will readily appreciate, training sequences are typically employed at the receiver for estimating the distortion and noise characteristics of a channel. For example, upon receiving a training sequence, the receiver compares the values associated with the received training sequence to the values associated with an expected training sequence. The receiver then utilizes the difference to characterize the channel (i.e., estimate the channel).

[0009] In order to use the training sequences to convey modulation selection information to the receiver, one or more training sequences must be assigned to each of the various modulation schemes. However, this solution also has a number of disadvantages. Foremost is the fact that it is difficult to identify an adequate number of unique training sequences with good auto correlation properties. Also, additional memory is required to store each of the additional training sequences. Furthermore, additional control software is needed to handle the additional training sequences.

[0010] Ideally, the receiver should be able to determine the modulation scheme associated with a

particular burst of information without advanced signaling from the transmitter, as advanced signaling introduces bandwith loss and transmission delays. Also, the receiver should be able to determine the modulation scheme during the channel estimation process (i.e., prior to the equalization process), as the equalization process is complex and modulation dependent. Furthermore, the receiver should be able to detect the modulation scheme independent of the fact that each, or at least two or more, modulation schemes employ the same training sequence and symbol rate.

SUMMARY OF THE INVENTION

[0011] The present invention involves a technique which allows a transmitter in a telecommunications system to transmit signaling information, such as information relating to modulation format, to a receiver without increasing the transmission bandwidth and without introducing any significant transmission delays. In general, the present invention accomplishes this by employing a symbol constellation phase rotation technique.

[0012] Accordingly, it is an object of the present invention to convey transmission information, such as modulation information, to a receiver in a telecommunications system without advanced signaling from the transmitter.

[0013] It is another object of the present invention to convey transmission information to a receiver in a telecommunications system without increasing overhead (i.e., without increasing the bandwidth requirements).

[0014] It is still another object of the present invention to convey transmission information to a receiver in a telecommunications system, wherein the receiver recognizes the information prior to equalization and independent of the training sequences and symbol rates used during channel estimation.

[0015] In accordance with one aspect of the present invention, the foregoing and other objects are achieved by a method and/or apparatus for transmitting signaling information from a transmitter to a receiver. The method and/or apparatus involves identifying one of a plurality of information signals to be conveyed from the transmitter to the receiver in addition to data and then rotating each of one or more symbols by a common phase rotation factor, wherein the phase rotation factor uniquely identifies the one information signal to be conveyed from the transmitter to the receiver. Each of the one or more phase-rotated symbols is then transmitted to the receiver.

[0016] In accordance with another aspect of the present invention, the foregoing and other objects are achieved by a method and/or apparatus for conveying modulation information from a transmitter to a receiver. The method and/or apparatus involves selecting one of a plurality of modulation schemes and modulating a sequence of training symbols in accordance with the selected one of the plurality of modulation schemes. A phase rotation factor is then identified which corresponds to the selected one of the plurality of modulation schemes, wherein at least one unique phase rotation factor is associated with each of the plurality of modulation schemes. The phase of each training symbol is then rotated as a function of the identified phase rotation factor which corresponds to the selected one of the plurality of modulation schemes, and the sequence of phase-rotated training symbols are transmitted to the receiver. At the receiver, a sequence of de-rotated training symbols is generated for each phase rotation factor by de-rotating the received sequence of phase-rotated training symbols as a function of each phase rotation factor. Each sequence of de-rotated training symbols is then compared to an expected sequence of training symbols, and the sequence of derotated training symbols that approximates the expected sequence of training symbols most accurately is identified. Finally, the selected one of the plurality of modulation schemes is identified based on the phase rotation factor that produced the sequence of de-rotated training symbols that most closely approximated the expected sequence of training symbols.

[0017] In accordance with yet another aspect of the present invention, the foregoing and other objects are achieved by a method and/or apparatus for identifying signaling information transmitted from a transmitter to a receiver along with data. The method and/or apparatus involves receiving a signal containing a sequence of symbols transmitted from the transmitter, wherein the symbols include training symbols and data symbols, and wherein the phase associated with each symbol in the sequence of symbols has been rotated at the transmitter in accordance with a common phase rotation factor that corresponds to the signaling information. Samples from the received signal are then generated, wherein the samples correspond to the sequence of transmitted symbols. The sequence of transmitted symbols is then recovered by de-rotating the samples in accordance with the common phase rotation factor; and the signaling information is identified as a function of the common phase rotation factor used to recover the sequence of transmitted symbols.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The objects and advantages of the present invention will be understood by reading the following detailed description in conjunction with the drawings in which:

[0019] FIGS. 1A-1B illustrate a phase rotation and phase de-rotation technique in accordance with the present invention;

[0020] FIGS. 2A-2D further illustrate the phase rotation and phase de-rotation technique in accordance with the present invention;

[0021] FIGS. 3A-3B illustrate exemplary configurations for a transmitter and a receiver respectively, in accordance with the present invention; and

[0022] FIGS. 4A-4B illustrate the use of a subset of points in a 4-PSK and an 8-PSK symbol constellation during training.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present invention entails a transmission technique wherein a transmitter, in a telecommunications system, such as a cellular radio telephone system, is capable of transmitting signaling information to a receiver, such as information relating to a selected modulation scheme associated with a burst of telecommunications data, without transmitting signaling in advance, without increasing the transmission bandwidth, and without increasing transmission delays. One skilled in the art will, however, readily appreciate the fact that the present invention can be utilized to efficiently transfer other types of transmission information, besides modulation information, as will be explained in greater detail below. In general, the present invention provides this capability by rotating the phase of the symbols to be transmitted, which may include a sequence of training symbols, by an angular amount that is uniquely associated with the signaling information to be transmitted. Consequently, the receiver is capable of identifying the information, based on the amount of phase rotation applied to the symbols at the transmitter.

[0024] FIGS. 1A and 1B illustrate the basic concept of the present invention. More specifically, FIG. 1A shows the transmitter sending a sequence of symbols (e.g., a sequence of training symbols) comprising four symbols N, N+1, N+2, and N+3. In the example illustrated in FIG. 1A, each symbol represents a single binary bit value, wherein the symbol N equals 0, the symbol N+1 equals 1, the symbol N+2 equals to 1, and the symbol N+3 equals to 0. Hence, the symbol sequence to be transmitted from the transmitter to the receiver is 0110.

[0025] In accordance with the present invention, a predetermined amount of phase rotation uniquely associated with the modulation scheme is introduced for each symbol. In the example illustrated in FIG. 1A, the phase rotation introduced involves a phase rotation factor of -[pi]/4. Accordingly, the symbol N is transmitted with a logical value of 0 and a phase rotation of 0 (i.e., 0*-[pi]/4); the symbol N+1 is transmitted with a logical value of 1 and a phase rotation of -[pi]/4 (i.e., 1*-[pi]/4); the symbol N+2 is transmitted with a logical value of 1 and a phase rotation of -[pi]/2 (i.e., 2*-[pi]/4); and the symbol N+3 is transmitted with a logical value of 0and a phase rotation of -3[pi]/4

[0026] While FIG. 1A illustrates the basic concept of the present invention with respect to the transmitter, FIG. 1B illustrates the basic concept of the present invention with respect to the receiver. In order for the receiver to recapture the transmitted sequence 0110, the receiver must de-rotate each of the received samples until the expected value is detected. In doing so, the receiver is able to recognize that a phase rotation factor of [pi]/4 is needed to recapture the sequence 0110. More specifically, upon receiving the first sample N, the receiver need not de-rotate the sample at all (i.e., a phase rotation of 0*[pi]4) to recapture the expected sample value of 0. However, upon receiving the second sample N+1, the receiver recognizes that it must de-rotate the received sample by a factor of [pi]/4 to recapture the second expected sample value 1. Upon receiving the third sample N+2, the receiver recognizes that it must de-rotate the received sample by an additional factor of [pi]/4 (i.e., a total phase rotation of 2*[pi]/4) to recapture the third expected sample value 1. Likewise, upon receiving the fourth sample N+3, the receiver recognizes that it must de-rotate the received sample by yet another factor of [pi]/4 (i.e., for a total phase rotation of 3*[pi]/4) to recapture the fourth expected sample value 0. Had the receiver de-rotated the received samples using a phase rotation factor other than [pi]/4, the receiver would have failed to recapture the sequence 0110. Accordingly, the receiver can use the phase rotation factor (e.g., -[pi]/4) as an indication of the modulation scheme. In a preferred embodiment, the process of determining the modulation scheme is accomplished during channel estimation so that the modulation scheme is known prior to the process of channel equalization.

[0027] FIGS. 2A-2D provide a second example to better illustrate a preferred embodiment of the present invention. In the example illustrated in FIGS. 2A-2D, it is assumed that the channel introduces no distortion or noise (i.e., the signal transmitted is identical to the signal received). It is also assumed that the telecommunications system employs two modulation schemes, for example, 4-PSK and 8-PSK. Furthermore, it is assumed that both modulation schemes employ the same binary training sequence 0110. As the training sequence is a binary training sequence, each symbol (i.e., each bit) identifies one of two points in the symbol constellation for both the 4-PSK and 8-PSK scheme, as illustrated in FIGS. 4A and 4B. FIGS. 4A and 4B also illustrate that in a preferred embodiment, the same two points on the symbol constellation are used for both the 4-PSK and the 8-PSK scheme during training, for example, the point a 0 and [pi]. It will be recognized, however, that the phase rotation technique of the present invention can be employed with longer and/or non-binary training sequences.

[0028] As previously explained, each modulation scheme is to be assigned a unique phase rotation factor. In the present example, the 4-PSK modulation scheme is assigned a phase rotation factor of -[pi]/4. The 8-PSK modulation scheme is assigned a phase rotation factor of [pi]/8.

[0029] FIG. 2A specifically shows the sequence of symbols N, N+1, N+2, and N+3 to be transmitted, wherein the first symbol N equals 0, the second symbol N+1 equals 1, the third symbol N+2 equals 1, and the fourth symbol N+3 equal 0. It should be noted that the four symbols N, N+1, N+2, and N+3in FIG. 2A have not yet been rotated.

[0030] In FIG. 2B, the four symbols have been rotated at the transmitter using a phase rotation factor of -[pi]/4, as the 4-PSK modulation scheme is currently being employed, though, as stated previously, only two of the four points on the 4-PSK symbol constellation are being used during training. Accordingly, the first symbol N remains unshifted, the second symbol N+1 has been rotated by -[pi]/4, the third symbol N+2 has been rotated by an additional -[pi]/4 for a total amount of rotation equal to -[pi]/2 (i.e., 2[pi]/4), and the fourth symbol N+3 has been rotated by yet another -[pi]/4 for a total amount of rotation equal to -[pi]/4.
[0031] Whereas FIGS. 2A and 2B illustrate the symbol sequence to be transmitted before and after phase rotation respectively, FIGS. 2C and 2D illustrate the received symbols (i.e., samples) after the receiver has de-rotated them. In a preferred embodiment of the present invention, the receiver de-rotates each of the received samples using the phase rotation factor associated with each modulation scheme employed by the telecommunications system. In the present example, there are two modulation schemes, 4-PSK and 8-PSK, as previously mentioned. The first modulation scheme, 4-PSK, was assigned the phase rotation factor of -[pi]/4, whereas the second modulation scheme, 8-PSK, was assigned the phase rotation factor of -[pi]/8. Accordingly, FIG. 2C illustrates the sequence of samples N, N+1, N+2 and N+3 after the receiver has de-rotated each by a phase rotation factor of [pi]/4. In contrast, FIG. 2D illustrates the sequence of samples N, N+1, N+2 and N+3 after the receiver has de-rotated each by a phase rotation factor of [pi]/8. Comparing FIG. 2C with FIG. 2D, one skilled in the art will appreciate that only by de-rotating the received samples by the appropriate phase rotation factor, [pi]/4 in the present case, is the receiver able to recover the expected sequence 0110. Therefore, the receiver is able to determine, based on the phase rotation factor required to recover the expected sequence 0110, that the current modulation scheme is 4-PSK rather than 8-PSK.
[0032] FIGS. 3A and 3B illustrate an exemplary, functional configuration for a transmitter and a receiver in accordance with the present invention. For instance, FIG. 3A represents a transmitter 300, wherein a sequence of training symbols N, N+1, N+2, and N+3 are modulated by modulation means 302. The particular modulation scheme employed is selected from one of a number of different modulation schemes M (e.g., 4-PSK) by means for selecting 304. A phase rotation selection function 305 then selects the appropriate phase rotation factor I thru R which corresponds to the selected modulation scheme. Each of the training symbols are then rotated accordingly, filtered by a pulse-shaping filter 310, and transmitted to an intended receiver. It will be understood that in a preferred embodiment of the present invention, the symbols representing data transmitted along with the training symbols are also rotated in accordance with the same phase rotation factor.
[0033] FIG. 3B illustrates the functional features which make up the intended receiver 325. Initially, the received signal (i.e., the analog signal containing the training symbols) is filtered by a receiver filter 330, and the samples corresponding to the training symbols are generated and forwarded to a number of phase de-rotation modules, for example, phase de-rotation module 335. Each of the phase de-rotation modules, as the name suggests, de-rotates the received training samples by one of the phase rotation factors 1-R. Accordingly, each de-rotation module generates a set of derotated training samples. A channel estimation function, for example, channel estimation function 340, then performs a channel estimation based on the corresponding set of de-rotated training samples. A channel filtering function, for example, channel filtering function 345, then adjusts an expected training sequence 350 as a function of the corresponding channel estimation. The expected, adjusted training sequence is then compared with the corresponding set of de-rotated training samples, so as to produce a corresponding error signal, for example, error signal 355. The error signals associated with each set of de-rotated training samples are then compared and the modulation scheme associated with the least amount of error is identified. After channel estimation, information/data samples associated with the present burst of data are derotated using the phase rotation factor associated with the identified modulation scheme.
[0034] If the telecommunications system does not use training sequences, phase rotation can still be employed to transmit signaling information. Without training sequences, the receiver might have an adaptive equalizer, whose parameters are changed continuously to minimize errors during equalization. Such errors can then be used by an adaptive algorithm to change the parameters (e.g., the filter coefficients in the equalizer) and to decrease the error. Typically, if the channel characteristics do not change rapidly, the errors will be large initially, though the errors will decrease later (assuming the correct modulation scheme was chosen).
[0035] In this alternative embodiment, the invention can be implemented as previously described with respect to the transmitter. However, at the receiver, instead of doing parallel channel estimations with different de-rotations, parallel adaptive equalization is accomplished assuming different de-rotations. After a sufficient period of time, the choice of rotation factor can be made based on error measured by the parallel adaptive equalization branches, wherein only the best equalization branch will continue.
[0036] In yet another embodiment, the receiver performs a coherent detection without the use of an equalizer. A RAKE receiver is an example of a receiver with this capability. RAKE receivers employ a ray tracking function to perform channel estimation, as is well known in the art.
[0037] As previously stated, GMSK is a non-linear modulation scheme, used, for example, in the GSM. According to differential precoding techniques, the binary information is transmitted with a +[pi]/2 phase shift if the present bit is the same as the previous bit, and a -[pi]/2 phase shift if the present bit is not the same as the previous bit. This way a transmitted symbol depends on the latest bit, and the bits previously

sent. Thus, it can be said that there is memory in the modulation. Therefore, conventional demodulation of a GMSK modulated signal requires that the receiver de-rotate the received samples by a phase rotation factor of [pi]/2.

[0038] If the present invention is used, for example, in conjunction with a telecommunications system that employs multiple modulation schemes, including GMSK, the phase rotation associated with the GMSK modulation scheme can be utilized by the receiver to distinguish a GMSK modulated signal from signals modulated in accordance with, for example, 8-PSK or 4-PSK. Of course, the 8-PSK and the 4-PSK modulation schemes would be assigned phase rotation factors other than [pi]/2. In a preferred embodiment of the present invention, the 4-PSK modulation scheme is assigned a phase rotation factor of [pi]/4. Whereas, the 8-PSK modulation scheme is assigned a phase rotation factor of [pi]/8. One skilled in the art will appreciate, however, that it is also possible to distinguish one of the latter two modulation schemes by assigning it a unique phase rotation factor, including a zero-phase rotation factor.

[0039] Although the present invention can be used for transmitting modulation information, one skilled in the art will appreciate that the present invention can also be used to implement an inband signaling channel that efficiently transmits signaling information, other than modulation information. For instance, it may be of interest to transmit coding information, or it may be of interest to transmit power control commands to order, for example, an increase or a decrease in the power level associated with the opposite link direction (i.e., the uplink or downlink direction).

[0040] In summary, the present invention provides a transmission technique wherein a transmitter in a telecommunications system that employs multiple modulation schemes, particularly for the purpose of link adaptation, to transmit modulation scheme information, and the like, to a receiver without increasing transmission bandwidth or transmission delay, despite the fact that the various modulation schemes may employ the same symbol rates and training sequences.

[0041] The present invention has been described with reference to a preferred embodiment. However, it will be readily apparent to those skilled in the art that it is possible to embody the invention in specific forms other than the preferred embodiment described above, and that this may be done without departing from the spirit of the invention. The preferred embodiment described above is illustrative and should not be considered restrictive in any way. The scope of the invention is given by the appended claims, rather than the preceding description, and all variations and equivalents which fall within the range of the claims are intended to be embraced therein.

[19]中华人民共和国国家知识产权局

[51]Int. Cl⁷
H04L 27/18
H04L 5/12

[12]发明专利申请公开说明书

[21]申请号 99801815.5

[43]公开日 2002年6月19日

[11]公开号 CN 1354945A

[22]申请日 1999.8.11 [21]申请号 99801815.5
[30]优先权
[32]1998.10.13 [33]US [31]09/170,127
[86]国际申请 PCT/IB99/01589 1999.8.11
[87]国际公布 WO00/10301 英 2000.2.24
[85]进入国家阶段日期 2000.6.12
[71]申请人 艾利森电话股份有限公司
地址 瑞典斯德哥尔摩
[72]发明人 M·赫克
S·亚韦尔布林
[74]专利代理机构 中国专利代理(香港)有限公司
代理人 王 岳 李亚非

权利要求书5页 说明书8页 附图页数7页

[54]发明名称 在数字通信系统中使用相位旋转技术发送信令

[57]摘要

在诸如蜂窝无线电信系统的一种电信系统中，从发射机向接收机 有效地传递传输信息，例如是调制方案选择信息，编码信息，或者是功 率电平控制指令，不需要增加带宽，并且不会导致附加的传输延迟。本 发明是采用数据符号相位旋转技术来实现，在其中按照一种唯一地对 应着准备传递给接收机的信息的相位旋转系数对一个数据符号序列 进行相位旋转，例如是用来评估给定信道的传播特性的一个训练符号 序列。在接收机上对符号进行解旋转，直至接收机恢复出训练序列。这样，接收机就能确定在发射机上用来旋转这些符号的相位旋转系数。随后就能识别出对应的传输信息。

ISSN1008-4274

知识产权出版社出版

权 利 要 求 书

1. 在数字电信系统中从发射机向接收机发送信令信息的一种方法包括以下步骤:

在数据之外识别准备从发射机传递给接收机的多个信息信号当中的一个;

用一个公用相位旋转系数旋转每一个或是多个符号,用相位旋转系数唯一地识别出准备从发射机传递给接收机的一个信息信号;以及

将每一个或是多个相位旋转的符号发送给接收机。

2. 按照权利要求1的方法,其特征是进一步包括以下步骤:

在接收机中接收包含一或多个相位旋转的符号的信号;

产生接收信号的采样,这种采样对应着相位旋转的符号;

对采样解旋转,恢复出对应每一或多个符号的值;以及

按照需要的相位旋转系数的函数识别出从发射机传递给接收机的一个信息信号,用于恢复与每一或多个符号有关联的值。

3. 按照权利要求 1 的方法,其特征是上述信息信号代表多种信号功率控制指令之一。

4. 按照权利要求 1 的方法,其特征是上述信息信号代表多种调制方案之一。

5. 按照权利要求 1 的方法,其特征是上述信息信号代表编码信息。

6. 按照权利要求1的方法,其特征是上述一或多个符号是训练符号。

7. 按照权利要求1的方法,其特征是上述一或多个符号包括训练和数据符号。

8. 在数字电信系统中从发射机向接收机传递调制信息的一种方法,该方法包括以下步骤:

选择多种调制方案之一;

按照多种调制方案中选定的一个方案调制训练符号的序列;

识别对应着多种调制方案中选定的一个方案的相位旋转系数,多种调制方案各自都有至少一个唯一的相位旋转系数;

旋转每个训练符号的相位,将其作为识别到的对应着多种调制方案中选定的一种方案的相位旋转系数的函数;

将相位旋转的训练符号的序列发送给接收机；

在接收机上通过对作为每个相位旋转系数的函数的接收到的相位旋转的训练符号的序列进行解旋转而为每个相位旋转系数产生一个解旋转的训练符号的序列；

将解旋转的训练符号的每个序列与一个预期的训练符号序列相比较；

识别出最接近预期的训练符号序列的解旋转的训练符号序列；

根据所产生的最接近预期的训练符号序列的解旋转的训练符号序列的相位旋转系数识别出多种调制方案中选定的一种方案。

9. 按照权利要求8的方法，其特征是进一步包括以下步骤：

为每个解旋转的训练符号序列获取一个信道评估值；以及

在将每个解旋转的训练符号序列与预期的训练符号序列相比较之前，按照对应着需要与预期的训练符号序列相比较的那个解旋转的训练符号序列所获取的信道评估值的函数来调节预期的训练符号序列。

10. 按照权利要求8的方法，其特征是选择多种调制方案之一的上述步骤是一种链路质量自适应估值的函数。

11. 按照权利要求8的方法，其特征是准备从发射机发送给接收机的两种以上调制方案的训练符号序列都是相同的。

12. 按照权利要求8的方法，其特征是在多种调制方案中选定的一种方案包括高斯最小频移键控。

13. 按照权利要求 8 的方法，其特征是在多种调制方案中选定的一种方案包括 4-相移键控。

14. 按照权利要求 8 的方法，其特征是在多种调制方案中选定的一种方案包括 8-相移键控。

15. 在数字电信系统中用来识别和数据一起从发射机向接收机发送的信令信息的一种方法，该方法包括以下步骤：

接收从发射机发送的包含一个符号序列的信号，这种符号中包括训练符号和数据符号，并且与符号序列中的每一个符号相关联的相位在发射机上已经按照对应着信令信息的一个公共相位旋转系数被旋转了；

从接收的信号产生采样，这种采样对应着发送的符号序列；

按照公共相位旋转系数对采样解旋转，恢复出发送的符号序列；并且

用公共相位旋转系数的函数识别出信令信息，用来恢复发送的符号序列。

16. 按照权利要求 15 的方法，其特征是进一步包括以下步骤：

按照多种不同的相位旋转系数对每一个采样解旋转，这其中多种不同的相位旋转系数各自对应着不同的信令信息，并且按照每一种不同的相位旋转系数对采样解旋转，为每一种不同的相位旋转系数产生一个解旋转的采样序列；

将每个解旋转的采样序列与一个预期的符号序列相比较；以及

识别出与最接近预期的符号序列的那个解旋转的采样序列相关联的相位旋转系数。

17. 在数字电信系统中从发射机向接收机发送信令信息的一种装置包括：

用来在数据之外识别准备从发射机传递给接收机的多个信息信号之一的装置；

用一个公用相位旋转系数旋转每一个或是多个符号的装置，用相位旋转系数唯一地识别出准备从发射机传递给接收机的一个信息信号；以及

将每一个或是多个相位旋转的符号发送给接收机的装置。

18. 按照权利要求 17 的装置，其特征是进一步包括：

在接收机中用于接收包含一或多个相位旋转的符号的装置；

产生接收信号采样的装置，这种采样对应着相位旋转的符号；

对采样解旋转的装置，恢复出对应每一或多个符号的值；以及

按照需要的相位旋转系数的函数识别出从发射机传递给接收机的一个信息信号的装置，用于恢复与每一或多个符号有关联的值。

19. 按照权利要求 17 的装置，其特征是上述信息信号代表多种信号功率控制指令之一。

20. 按照权利要求 17 的装置，其特征是上述信息信号代表多种调制方案之一。

21. 按照权利要求 17 的装置，其特征是上述信息信号代表编码信息。

22. 按照权利要求 17 的装置，其特征是上述一或多个符号是训练符号。

23. 按照权利要求 17 的装置，其特征是上述一或多个符号包括训练和数据符号。

24. 在数字电信系统中从发射机向接收机传递调制信息的一种装置，该装置包括：

用来选择多种调制方案之一的装置；

按照多种调制方案中选定的一个方案调制一种训练符号序列的装置；

用来识别对应着多种调制方案中选定的一个方案的相位旋转系数的装置，多种调制方案各自都有至少一个唯一的相位旋转系数；

用来旋转每个训练符号的相位的装置，将其作为识别到的对应着多种调制方案中选定的一种方案的相位旋转系数的函数；

用来将相位旋转的训练符号序列发送给接收机的装置；

在接收机上用来对作为每个相位旋转系数的函数的接收到的相位旋转的训练符号的序列进行解旋转的装置，从而为每个相位旋转系数产生一个解旋转的训练符号的序列；

用来将解旋转的训练符号的每个序列与一个预期的训练符号序列相比较的装置；

用来识别最接近预期的训练符号序列的解旋转的训练符号序列的装置；

根据所产生的最接近预期的训练符号序列的解旋转的训练符号序列的相位旋转系数识别出多种调制方案中选定的一种方案的装置。

25. 按照权利要求 24 的装置，其特征是进一步包括：

为每个解旋转的训练符号序列获取一个信道评估值的装置；以及

在将每个解旋转的训练符号序列与预期的训练符号序列相比较之前，按照对应着需要与预期的训练符号序列相比较的那个解旋转的训练符号序列所获取的信道评估值的函数来调节预期的训练符号序列的装置。

26. 按照权利要求 24 的装置，其特征是选择多种调制方案之一的上述装置是一种链路质量自适应估值的函数。

27. 按照权利要求 24 的装置，其特征是准备从发射机发送给接收机的两种以上调制方案的训练符号序列都是相同的。

28. 按照权利要求 24 的装置，其特征是在多种调制方案中选定的一种方案包括高斯频移键控。

29. 按照权利要求 24 的装置，其特征是在多种调制方案中选定的一种方案包括 4-相移键控。

30. 按照权利要求 24 的装置，其特征是在多种调制方案中选定的一种方案包括 8-相移键控。

31. 在数字电信系统中用来识别和数据一起从发射机向接收机发送的信令信息的一种装置，该装置包括：

用来接收从发射机发送的包含一个符号序列的信号的装置，这种符号中包括训练符号和数据符号，并且与符号序列中的每一个符号相关联的相位在发射机上已经按照对应着信令信息的一个公共相位旋转系数被旋转了；

从接收的信号产生采样的装置，这种采样对应着发送的符号序列；

按照公共相位旋转系数对采样解旋转的装置，恢复出发送的符号序列；以及

利用公共相位旋转系数的函数识别出信令信息的装置，用来恢复发送的符号序列。

32. 按照权利要求 31 的装置，其特征是进一步包括：

按照多种不同的相位旋转系数对每一个采样解旋转的装置，其中的多种不同的相位旋转系数各自对应着不同的信令信息，并且按照每一种不同的相位旋转系数对采样解旋转，为每一种不同的相位旋转系数产生一个解旋转的采样序列；

用于将每个解旋转的采样序列与一个预期的符号序列相比较的装置；以及

用于识别与最接近预期的符号序列的那个解旋转的采样序列相关联的相位旋转系数的装置。

说 明 书

在数字通信系统中使用相位旋转技术发送信令

本发明涉及到数字通信系统，具体地说，本发明涉及到在不需要增加带宽并且不会导致传输延迟的条件下从发射机向接收机传输信息。

数字电信系统统称采用一种上述的调制方案来完成诸如话音，数据和/或控制信息的通信。这些调制方案中包括 GMSK(高斯最小频移键控)，M-ary QAM(正交幅度调制)，或是 M-ary PSK(相移键控)，其中的 M 表示为不同调制方案规定的调制符号的数量。不同的调制符号对应着需要传输的不同的信息符号。例如，在 M=2 的调制方案中仅仅规定了两个不同的调制符号。因而将 M=2 的调制方案称为二进制调制方案。

不同类型的调制受到通信信道质量的影响也可能是不同的，也就是说，不同的方案或多或少地发生畸变，时间漂移和 C/I 比等等。因此有人说不同的方案具有不同的健全等级。一般来说，随着调制符号数量也就是 M 值的增加，调制方案会越来越不健全。然而，诸如符号速率等等其它因素也可能影响一种调制方案的健全。一种给定的调制方案以及不同的调制方案之间也可能规定不同的符号速率。

为了相对于信息位速率和误码率保证适当的通信质量，可以采用链路适应技术。根据通信信道(随时间变化)的质量来选择能够保证合适的调制方案，信道编码，源代码，带宽和信号功率电平的链路适应策略，以便获得在误码率，通过量等方面能够满足用户要求的链路质量，信道的质量可能会受到噪声电平，干扰，路径损耗和时间漂移的影响。真正有效的链路适应技术必须能在比较短的时间周期内监视和/或测量信道状态。然后，系统根据现有的信道状态来选择调制方案或是优化链路质量的方案。

采用时分多址联接(TDMA)的电信系统是将可用的频带划分成若干个射频信道。然后再将这些射频信道进一步划分成若干个物理信道或是时隙。然后用短脉冲发送话音，数据和/或控制信息，一个短脉冲对应着一个物理信道或是时隙。在以 TDMA 为基础的系统中，链路适应和调制选择通常是在逐个短脉冲的基础上完成的。然而还需要指出，链路适应并非仅限于 TDMA 系统。在基于其他接入原理的系统中也可

以执行链路适应。例如是在 CDMA(码分多址联接)系统中可以通过改变编码,调制和漂移因素而获得理想的链路质量.

任何链路适应和调制选择技术的一个重要方面是发射机如何用一个特殊的短脉冲信息将选定的调制方案通知给接收机。将关于一个特定短脉冲信息的调制方案通知接收机的最直接的技术可能就是预先向接收机发送信号。然而,这种技术是很不理想的,因为会导致额外的附加位(即增加了需要的带宽),随之又会导致传输延迟.

向接收机传送调制选择信息的另一种技术是使用训练序列. 正如本领域的技术人员所知,接收机通常采用训练序列来评估一个信道的畸变和噪声特性。例如,在接收到一个训练序列时,接收机将涉及接收到的训练序列的值与涉及一种预期训练序列的值相比较。接收机利用比较的差别来表示信道的特征(也就是对信道进行评估)。

为了用训练序列向接收机传送调制选择信息,必须为各种调制方案各自分配一或多个训练序列. 然而,这种方案仍然存在许多缺点. 首先是难以确定足够数量的具有良好的自动关联特性的唯一的训练序列。另外还需要额外的存储器来存储每个额外的训练序列。再有,还需要额外的控制软件来处理额外的训练序列.

理想的情况是,接收机应该能够确定关于一个特定短脉冲信息的调制方案,而不需要预先从发射机发送信令,因为预先发送信令会导致带宽损失和传输延迟。另外,由于均衡程序很复杂并且依赖于调制,接收机还应该能够在信道评估程序(也就是在均衡程序之前)中确定调制方案。进而,接收机还应该能够从采用相同的训练序列和符号速率的每个或是至少两个或更多的调制方案中单独检测出一种调制方案。

本发明涉及到一种技术,能够让电信系统中的发射机在不增加传输带宽并且不会导致任何明显的传输延迟的条件下向接收机发送信令信息,例如是关于调制格式的信息。总地来说,本发明是采用一种符号星座相位旋转技术而实现的。

与此相应,本发明的目的是在电信系统中向接收机传递传输信息,例如是调制信息,而不需要预先从发射机发送信令.

本发明的另一个目的是在电信系统中向接收机传递传输信息,而不需要增加附加位(也就是不增加需要的带宽)。

本发明的再一个目的是在电信系统中向接收机传递传输信息，接收机在均衡之前识别这种信息，并且与信道评估期间使用的训练序列和符号速率无关。

按照本发明的一个方面，上述和其他的目的是用一种从发射机向接收机发送信令信号的方法和/或装置来实现的。该方法和/或装置包括在数据之外识别准备从发射机传递给接收机的多个信息信号当中的一个，然后用一个公用相位旋转系数旋转每一个或是多个符号，用相位旋转系数唯一地识别出准备从发射机传递给接收机的一个信息信号。然后将每一个或是多个相位旋转的符号发送给接收机。

按照本发明的另一个方面，上述和其他的目的是用一种从发射机向接收机传递调制信息的方法和/或装置来实现的。该方法和/或装置包括从多个调制方案中选择一个方案，并且按照多个调制方案中选定的一个方案来调制训练符号的序列。然后识别对应着多个调制方案中选定的一个方案的相位旋转系数，多个调制方案各自都有至少一个唯一的相位旋转系数。然后旋转每个训练符号的相位，将其作为识别到的对应着多个调制方案中选定的一个方案的相位旋转系数的函数，并且将相位旋转的训练符号的序列发送给接收机。在接收机上通过对作为每个相位旋转系数的函数的接收到的相位旋转的训练符号的序列进行解旋转而为每个相位旋转系数产生一个解旋转的训练符号的序列。然后将解旋转的训练符号的每个序列与一个预期的训练符号序列相比较，识别出最接近预期的训练符号序列的每一个解旋转的训练符号序列。最后根据所产生的最接近预期的训练符号序列的解旋转的训练符号序列的相位旋转系数识别出多个调制方案中选定的一种方案。

按照本发明的再一个方面，上述和其他的目的是用一种用来识别和数据一起从发射机向接收机发送的信令信息的方法和/或装置来实现的。该方法和/或装置包括接收从发射机发送的包含一个符号序列的信号，这种符号中包括训练符号和数据符号，并且与符号序列中的每一个符号相关联的相位在发射机上已经按照对应着信令信息的一个公共相位旋转系数被旋转了。然后从接收的信号产生采样，这种采样对应着发送的符号序列。然后按照公共相位旋转系数对采样解旋转，恢复出发送的符号序列；并且用公共相位旋转系数的函数识别出信令

信息，用来恢复发送的符号序列。

通过参照附图阅读以下的具体说明就能够理解分发明的目的和优点，在附图中：

图 1A-1B 表示按照本发明的相位旋转和相位解旋转技术；

图 2A-2D 进一步说明了按照本发明的相位旋转和相位解旋转技术；

图 3A-3B 分别示意性地表示了按照本发明的发射机和接收机的结构；以及

图 4A-4B 表示在训练期间如何使用一个 4-PSK 和一个 8-PSK 符号星座中的点的子集。

本发明提出了一种传输技术，在诸如蜂窝无线电话系统的一个电信系统中的发射机能够向接收机发送信令信息，例如是涉及到与电信数据的一个短脉冲有关的一种选定的调制方案的信息，不需要预先发送信令，不会增加传输带宽，并且不会增加传输延迟。然而，正如下文中更具体的说明，本领域的技术人员很容易看出，除了调制信息之外，也可以利用本发明的原理有效地传递其他类型的传输信息。一般来说，本发明是通过旋转准备发送的可能包括一个序列的训练符号的这种符号的相位而实现这一目的的，让角度量唯一地对应准备发送的信令信息。这样，接收机就能根据在发射机上对这些符号采取的相位旋转量识别出这种信息。

图 1A 和 1B 表示本发明的基本概念。具体地说，图 1A 表示发射机传送由四个符号 N, N+1, N+2 和 N+3 构成的一个符号序列(例如是一种训练符号序列)。在图 1A 所示的例子中，每个符号代表一个单一的二进制位值，其中的符号 N 等于 0，符号 N+1 等于 1，符号 N+2 等于 1，而符号 N+3 等于 0. 因此，准备从发射机发送给接收机的这一符号序列就是 0110。

按照本发明，对每一个符号采用唯一地联系着调制方案的一种预定的相位旋转量。在图 1A 所示的例子中采用的相位旋转包括 $-\pi/4$ 的相位旋转系数。因此，符号 N 是按照逻辑值 0 和 0 相位旋转(即 $0*\pi/4$)发送的；符号 N+1 是按照逻辑值 1 和 $-\pi/4$ 的相位旋转(即 $1*-\pi/4$)发送的；符号 N+2 是按照逻辑值 1 和 $-\pi/2$ 的相位旋转(即 $2*-\pi/4$)发送的；而 符号 N+3 是按照逻辑值 0 和 $-3\pi/4$ 的相位旋转(即

3*-π/4)发送的。

图 1A 表示了本发明中关于发射机的基本概念，而图 1B 则表示本发明中关于接收机的基本概念。为了让接收机能够捕捉到发送的序列 0110，接收机必须对每一个接收的采样解旋转，直至检测到预期的值。为此，为了捕捉到序列 0110，接收机必须能够识别出 π/4 的相位旋转系数。具体地说，在接收到第一个采样 N 时，接收机完全不需要对采样进行解旋转(即相位旋转为 0*π/4)就能捕捉到预期的采样值 0。然而，在接收到第二个采样 N+1 时，接收机发现必须要用 π/4 的旋转系数对接收的采样解旋转才能捕捉到第二个预期的采样值 1。在接收到第三个采样 N+2 时，接收机发现必须要用一个额外的系数 π/4(总的相位旋转是 2*π/4)对接收的采样解旋转才能捕捉到第三个预期的采样值 1。同样，在接收到第四个采样 N+3 时，接收机发现必须要再用一个系数 π/4(总的相位旋转是 3*π/4)对接收的采样解旋转才能捕捉到第四个预期的采样值 0。如果接收机用 π/4 之外的相位旋转系数对接收的采样解旋转，接收机就不能捕捉到序列 0110。因此，接收机可以用这种相位旋转系数(即-π/4)来表示调制方案。在一个最佳实施例中，确定调制方案的程序是在信道评估的过程中完成的，这样就能在信道均衡的程序之前得知调制方案。

图 2A-2D 提供的第二个例子可以更好地说明本发明的实施例。在图 2A-2D 所示的例子中，假设信道不会带来畸变或是噪声(也就是说发送的信号和接收的信号是相同的)。同时假设电信系统中采用了两种调制方案，例如是 4-PSK 和 8-PSK。另外还假设两种调制方案都采用相同的二进制训练序列 0110。如图 4A 和 4B 所示，对于 4-PSK 和 8-PSK 来说，由于训练序列是一种二进制训练序列，每个符号(也就是每一位)代表符号星座中的两点之一。图 4A 和 4B 还表示，在一个最佳实施例中，4-PSK 和 8-PSK 方案在训练期间都使用符号星座上相同的两个点，例如是点 0 和 π。然而还应该认识到，本发明的相位旋转技术还可以采用更长的和/或非二进制的训练序列。

如上所述，为每一种调制方案指定一种唯一的相位旋转系数。在本实施例中，为 4-PSK 调制方案指定的相位旋转系数是-π/4。为 8-PSK 调制方案指定的相位旋转系数是-π/8。

图 2A 具体表示了准备发送的符号序列 N，N+1，N+2 和 N+3，在其中

第一个符号 N 等于 0，第二个符号 N+1 等于 1，第三个符号 N+2 等于 1，而第四个符号 N+3 等于 0。应该注意到图 2A 中的四个符号 N，N+1，N+2 和 N+3 还没有被旋转。

在图 2B 中，四个符号在发射机中用 $-\pi/4$ 的相位旋转系数被旋转了，如上所述，由于此处采用了 4-PSK 的调制方案，在训练期间仅仅使用了 4-PSK 符号星座上的四个点当中的两个点。因此，第一个符号 N 维持不变，第二个符号 N+1 被旋转了 $-\pi/4$，第三个符号 N+2 又被旋转了 $-\pi/4$，旋转的总量等于 $-\pi/2$（即 $-2\pi/4$），而第四个符号 N+3 再旋转一个 $-\pi/4$，旋转的总量等于 $-3\pi/4$。

图 2A 和 2B 分别说明了相位旋转前、后的准备发送的符号序列，而图 2C 和 2D 表示接收机对它们完成解旋转之后的接收的符号（也就是采样）。在本发明的最佳实施例中，接收机使用与电信系统中采用的每一种调制方案相应的相位旋转系数对每个接收的采样解旋转。如上所述，在本实施例中有两种调制方案 4-PSK 和 8-PSK。为第一种调制方案 4-PSK 指定的相位旋转系数是 $-\pi/4$，第二种调制方案 8-PSK 指定的相位旋转系数是 $-\pi/8$。与此相应，图 2C 表示了接收机用 $\pi/4$ 的相位旋转系数逐个解旋转之后的采样序列 N，N+1，N+2 和 N+3。反之，图 2D 表示了接收机用 $\pi/8$ 的相位旋转系数逐个解旋转之后的采样序列 N，N+1，N+2 和 N+3。对比图 2C 和图 2D，本领域的技术人员就可以看出接收机只有用合适的相位旋转系数对接收的采样解旋转才能恢复预期的序列 0110，在此处就是 $\pi/4$。这样，接收机就能根据需要的相位旋转系数恢复出预期的序列 0110，因为目前的调制方案是 4-PSK 而不是 8-PSK。

图 3A 和 3B 示意性地表示了本发明的发射机和接收机的功能结构。例如，图 3A 表示发射机 300，其中的训练符号序列 N，N+1，N+2 和 N+3 是按照许多不同调制方案 M（例如是 4-PSK）中选定的一种方案来调制的。然后用相位旋转选择功能 305 选择适当的相位旋转系数 1 到 R，它对应着选定的调制方案。然后相应地旋转每个训练符号，用一个脉冲整形滤波器 310 滤波，并且发送给指定的接收机。在本发明的实施例中，代表着和训练符号一起发送的数据的符号也是按照同样的相位旋转系数旋转的。

图 3B 表示构成了指定的接收机 325 的功能特征。最初，用接收机

滤波器 330 对接收的信号(也就是包含训练符号的模拟信号)滤波，并且产生对应着训练符号的采样，并且提供给许多相位解旋转模块，例如是相位解旋转模块 335. 每个相位解旋转模块用一种相位旋转系数 1-R 对接收的训练采样解旋转。然后由例如信道评估功能 340 的一个信道评估功能根据对应的一组解旋转的训练采样执行信道评估。然后由例如信道滤波功能 345 的一个信道滤波功能按照对应着信道评估的函数来调节预期的训练序列 350。然后将经过调节的预期的训练序列和对应的一组解旋转的训练采样相比较，产生一个对应的误差信号，例如是误差信号 355。然后比较关于每一组解旋转的训练采样的误差信号，并且识别出至少与一定的误差量有关的调制方案。在信道评估之后，使用与识别到的调制方案相应的相位旋转系数对当前的数据端脉冲有关联的信息/数据采样解旋转。

如果电信系统不使用训练序列，仍可以采用相位旋转技术发送信令信息。如果没有训练序列，接收机就需要有一个自适应均衡器，为了在均衡期间减少误差，它的参数是连续变化的。然后，自适应算法可以用这种误差改变参数(即均衡器中的滤波器系数)。在典型的情况下，如果信道特性没有急剧的变化，尽管误差会逐渐减少(假设是选择了正确的调制方案)，最初的误差可能很大。

在另一个实施例中可以按照前述的关于发射机的方式实现本发明。然而，在接收机上利用针对不同的解旋转的并列的自适应均衡代替了并列的信道评估工作。在经过足够的时间周期之后，可以根据并列的自适应均衡分支测定的误差来选择旋转系数，只有最佳的评估分支是连续的。

在又一个实施例中，接收机不需要使用均衡器就能执行连贯的检测。RAKE 接收机就是具有这种能力的接收机的一个例子。RAKE 接收机采用射线跟踪功能来执行信道评估，这是公知的现有技术。

如上所述，GMSK 是在 GSM 中使用的一种非线性调制方案。按照不同的编码技术，如果这一位与前一位相同，二进制信息是用 $+\pi/2$ 相位移发送的，如果这一位与前一位不同，就是用 $-\pi/2$ 相位移发送的。这样发送的符号取决于最后一位和前面发送的位。因而可以说有一种对调制的记忆。因此，对 GMSK 调制信号的惯用的解调制需要接收机用 $\pi/2$ 的相位旋转系数对接收的采样解旋转。

如果使用本发明，例如是配合着采用包括GMSK在内的多种调制方案的电信系统，接收机可以利用与GMSK调制方案相联系的相位旋转根据按照8-PSK或是4-PSK调制的信号鉴别出一个GMSK调制的信号。当然，也可以为8-PSK或是4-PSK调制方案指定π/2之外的相位旋转系数。在本发明的实施例中，为4-PSK调制方案指定的相位旋转系数是π/4。同时，为8-PSK指定的相位旋转系数是π/8。然而，本领域的技术人员可以看出也可以通过为调制方案指定一种包括零相位旋转系数在内的一个唯一的相位旋转系数而从后两种调制方案中鉴别出一种方案。

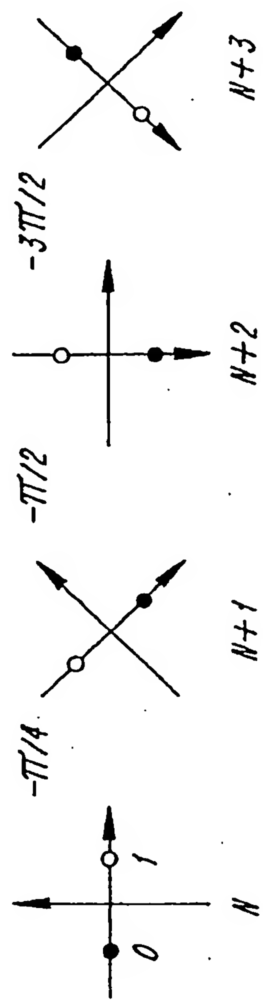
尽管本发明可以被用来发送调制信息，本领域的技术人员也可以看出本发明还可以用来构成一个带内的信令信道，用来有效地发送调制信息之外的其他信令信息。例如，有可能需要发送编码信息，或者是用来发送功率控制指令，例如是命令提高或是降低与相反的链路方向(即上行或是下行方向)有关的功率电平。

总之，本发明提供了一种传输技术，让电信系统中特别是用于链路自适应的采用多种调制方案的发射机向接收机发送调制方案等等信息，不需要增加传输带宽或是传输延迟，无论采用哪一种调制方案，符号速率和训练序列都是相同的。

本发明是参照其最佳实施例来说明的。然而，本领域的技术人员很容易看出有可能用上述最佳实施例之外的特定形式来实现本发明，而这些实现方式都没有脱离本发明的原理。上述的实施例是示意性的，不应该被理解为任何形式的限制。本发明的范围是由所附的权利要求书而不是上文的说明所限定的，落在权利要求书范围内的所有变更和等效产物都被包含在内。

00·06·12

用-π/4 系数旋转发送符号序列的相位



○ 不发送
● 发送

图 1A

用 π/4 系数对接收的采样序列解旋转

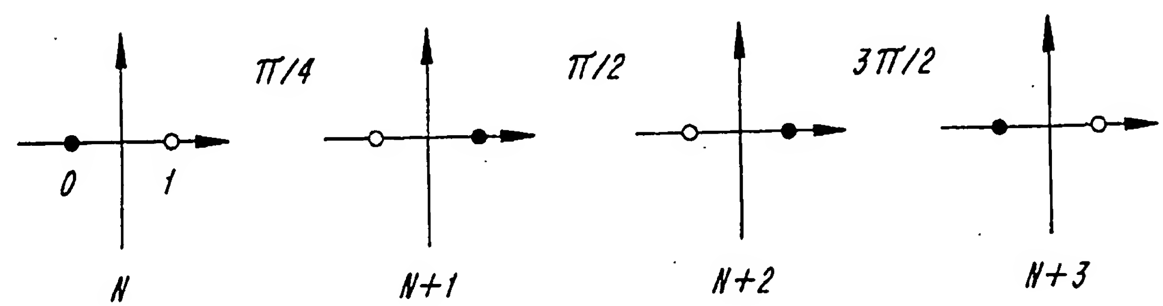


图 1B

相位旋转之前的准备发送的符号序列

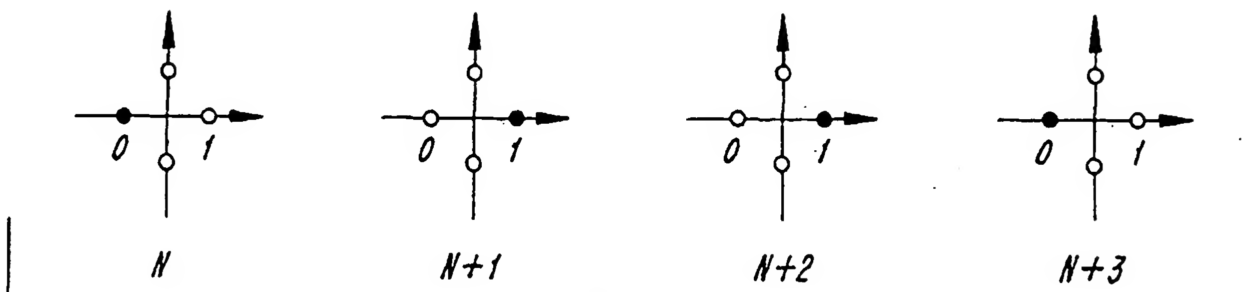


图 2A

用-π/4系数相位旋转之后的准备发送的符号序列

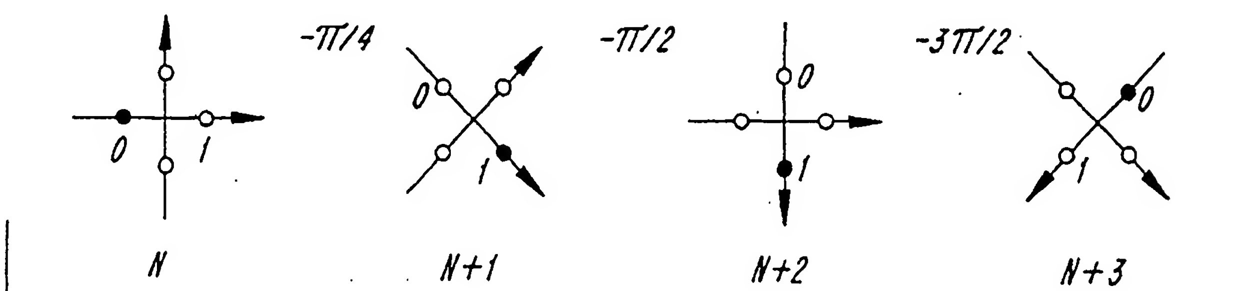


图 2B

按照 π/4 系数解旋转之后接收到的采样序列

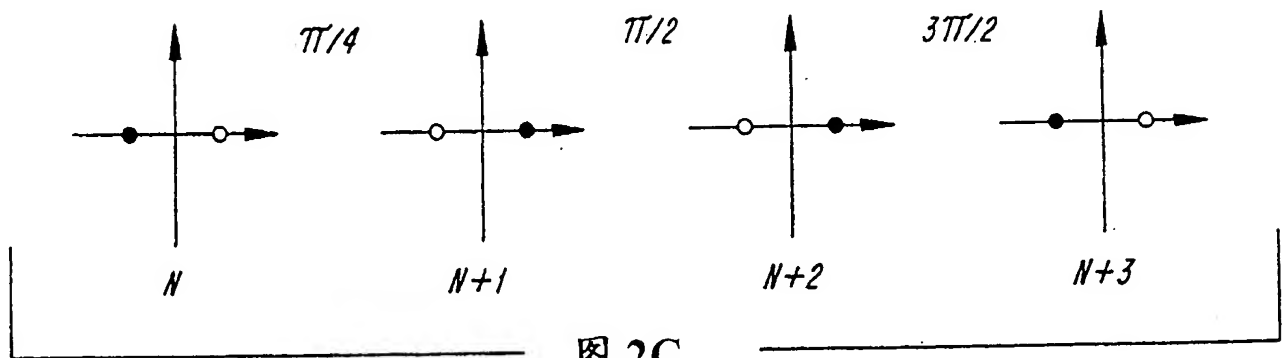


图 2C

按照 π/8 系数解旋转之后接收到的采样序列

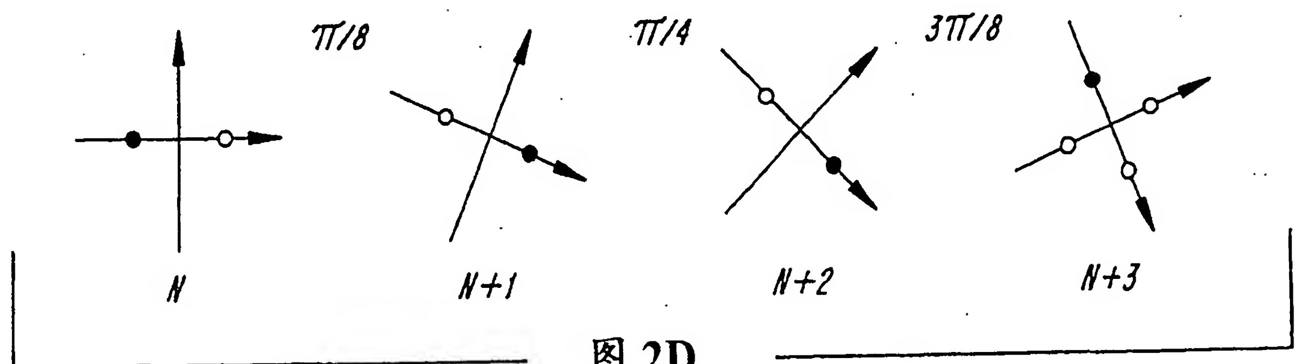


图 2D

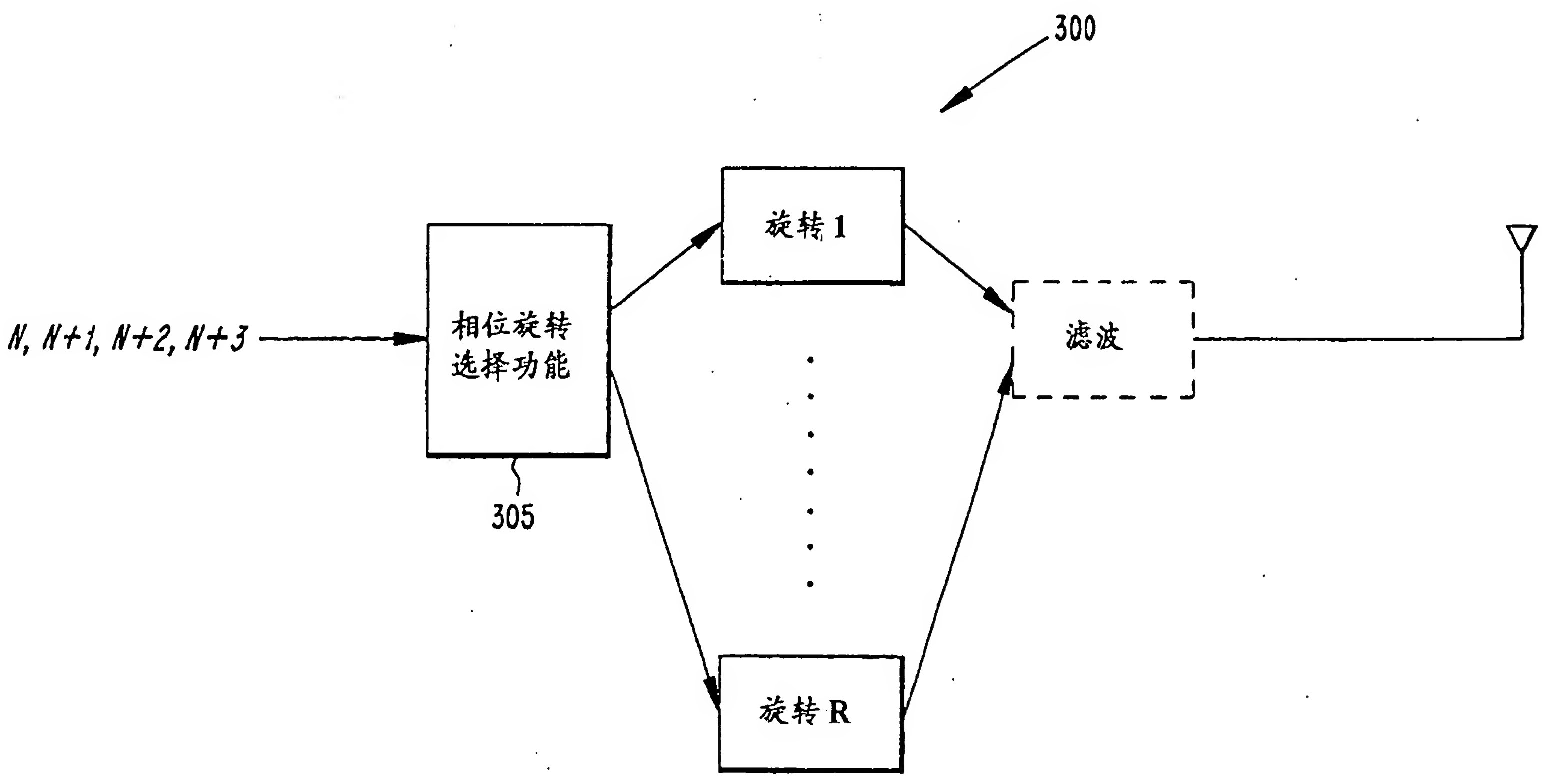


图 3A

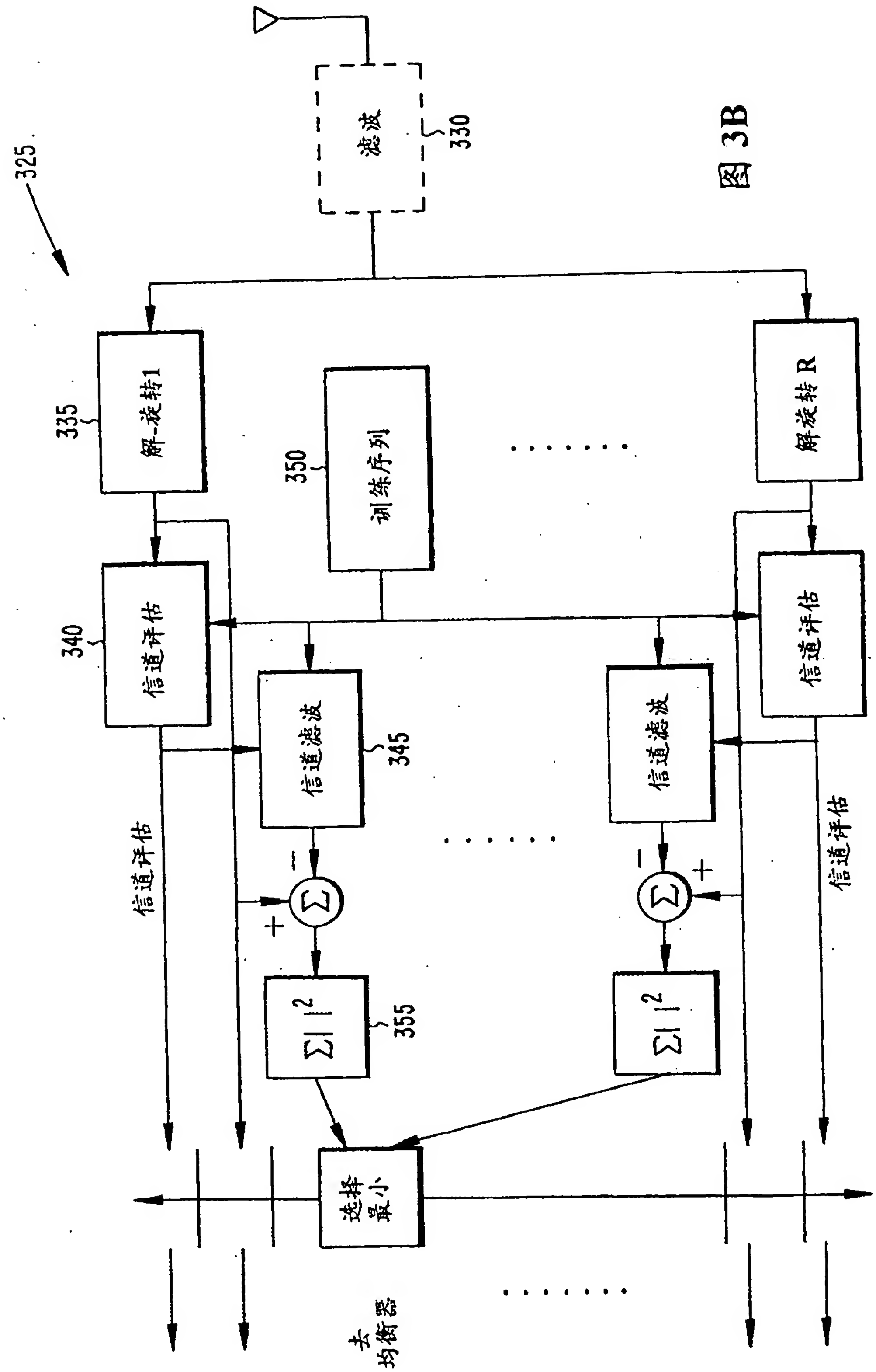

325
滤波
330
解-旋转1
335
训练序列
350
解旋转 R
信道评估
340
信道评估
信道滤波
345
信道滤波
Σ
Σ| |²
355
Σ| |²
信道评估
信道评估
选择最小
去均衡器

图 3B

00.06.12

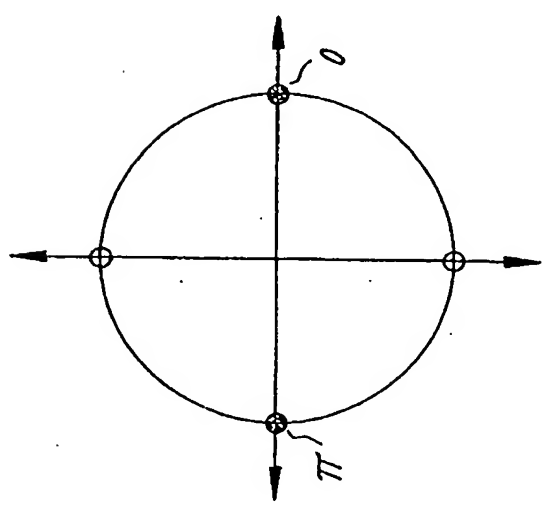


图 4A

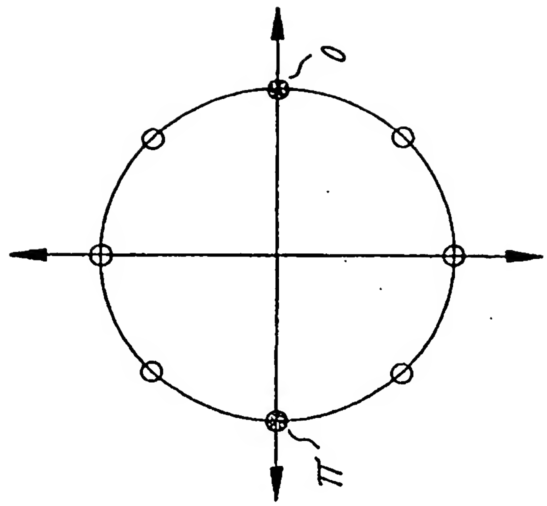


图 4B